URODYNAMIC RESULTS OF LASER TREATMENT IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA. CAN OUTLET OBSTRUCTION BE RELIEVED?


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ABSTRACT

Purpose: A urodynamic study was done to judge the capability of laser treatment to relieve bladder outlet obstruction.

Materials and Methods: Advanced urodynamic studies with pressure-flow analysis were performed before and 6 months after laser treatment using 3 different laser devices.

Results: Forty patients showed significant improvement in all obstruction parameters (detrusor pressure at maximum flow rate, urethral resistance relation, theoretical cross-sectional urethral area, minimal detrusor pressure and linear passive urethral resistance relation) together with significant subjective improvement in international prostate symptom score. After treatment 92% of the patients could no longer be considered to have obstruction. No difference in outcome among the devices used was found.

Conclusions: Laser prostatectomy is indeed capable of relieving bladder outlet obstruction.

KEY WORDS: prostatic hypertrophy, urodynamics, prostatectomy, lasers

For more than 7 decades prostates have been enucleated surgically and for almost 6 decades they have been resected endoscopically. Results have been impressive and increasingly better, and the procedures are reasonably safe. In the 1980s many alternatives to prostatectomy have surfaced, from a pharmacological approach to numerous procedural alternatives, for example balloon dilation, prostatic stents, hyperthermia and thermotherapy. To date, none of these alternatives have reached subjective and objective results comparable to those noted after enucleation or resection of the prostate. Nevertheless, the morbidity of the operations is still greater than that for any of these alternatives.

Recently, a new instrumental treatment modality for benign prostatic hypertrophy (BPH) became available, that is laser treatment of the prostate. The advantages of laser treatment are the minimal hospital stay, minimal bleeding, no fluid absorption, rapidity of treatment, technical simplicity and chance of preservation of antegrade ejaculation. Although present studies include few patients and the follow-up is short, the results after laser treatment are comparable to those achieved after electrosurgery.

To replace transurethral resection of the prostate by laser prostatectomy, the latter procedure should also be able to relieve outlet obstruction. In general patients are evaluated preoperatively and postoperatively by means of symptom scores, uroflowmetry studies, post-void residual volume and prostate size. These parameters are associated with obstructive voiding or not with the grade of obstruction and, therefore, they cannot be used to determine objectively whether outlet obstruction is relieved.

To quantify the grade of bladder outlet obstruction, urodynamic investigation with pressure-flow analysis is considered the gold standard. We judged the obstruction relieving capabilities of laser treatment of the prostate.

PATIENTS AND METHODS

Since November 1992 we treated 125 patients with 3 different laser systems: the Intra Sonic TULIP device, the Bard Urolase fiber and the Heraeus Ultraline fiber. All patients underwent a screening program consisting of physical examination (including digital rectal examination), biochemistry (including prostate specific antigen [PSA]), and urine culture analysis (including prostate specific antigen [PSA]).

Patient selection is based on various parameters. To be eligible for laser treatment, uroflowmetry studies, post-void residual volume and prostatic volume had to be less than 350 ml. If patients fit these criteria, they were eligible for laser treatment. Urodynamic investigations were performed with an 8F transurethral lumen catheter with an intravesical micro-tip pressure sensor. Abdominal pressure was recorded intrarectally with a 3000 uroflowmeter. The voided volume had to be at least 150 ml. The post-void residual volume, measured by transabdominal ultrasonography, had to be less than 350 ml. If patients fit these criteria, they were eligible for laser treatment. Urodynamic investigations were performed with an 8F transurethral lumen catheter with an intravesical micro-tip pressure sensor. Abdominal pressure was recorded intrarectally with a 3000 uroflowmeter. The voided volume had to be at least 150 ml. The post-void residual volume, measured by transabdominal ultrasonography, had to be less than 350 ml. If patients fit these criteria, they were eligible for laser treatment.
Different parameters were used to document obstruction, including the detrusor pressure at maximum flow rate (grading according to the Abrams-Griffiths nomogram), intersection of quadratic urethral resistance relation with the pressure axis of pressure flow (urethral resistance relation), parameters calculated from the passive urethral resistance relation (minimal detrusor pressure with ongoing flow and theoretical cross-sectional area of the urethra) and linear passive urethral resistance relation (an approximation of the resistance relation by means of a straight line through minimal detrusor pressure and detrusor pressure at maximum flow rate with grading according to the Schäfer nomogram). The majority of patients studied were classified as having urodynamic obstruction depending on the urodynamic parameter used.

Before laser treatment, a suprapubic catheter was inserted for continuous flow through the endoscopic instruments. The day after laser treatment the patients were discharged from the hospital with the suprapubic catheter in situ. At the outpatient clinic the catheter was removed when voiding was satisfactory without a significant post-void residual volume. At 4, 12 and 26 weeks the patients were evaluated with blood studies and urinalysis, uroflowmetry, and international prostate symptom score, quality of life and sexual function questionnaires. At week 26 urodynamic investigations, transrectal ultrasound of the prostate and cystoscopy were repeated. The Wilcoxon signed-rank test was used for statistical comparison of the preoperative and postoperative data.

RESULTS

To date 40 of the 125 patients treated were evaluable for urodynamic analysis 6 months after laser prostatectomy. Mean patient age in this group was 63.8 years (range 51 to 76). Mean values at baseline for patient age, prostate size, peak urinary flow rates, post-void residual volume and international prostate symptom scores for the complete group are shown in table 1.

The changes in the parameters used are shown in table 2. All patients had an improvement in symptom scores. A mean international prostate symptom score at baseline of 21.7 ± 6.6 (range 12 to 35) improved to 6.3 ± 4.6, with an individual improvement of 15.4 ± 8.1 at 6 months. Mean peak urinary flow rate changed from 8.0 ± 3.1 mL per second (range 2.0 to 14.0) preoperatively to 17.1 ± 5.9 mL per second (range 9.3 to 30) at 6 months. The mean individual improvement in peak urinary flow rate was 9.0 ± 6.2 mL per second (range 3.1 to 20.0). The post-void residual volume decreased from a mean 89.2 ± 102.3 mL (range 0 to 350) at baseline to 18.2 ± 38.4 mL (range 0 to 190) with a mean improvement of 71.0 ± 102.3 mL (range –135 to 350) at 6 months. All of these parameters demonstrated a statistically significant improvement (p < 0.0001). Table 2 also shows the improvements in mean values of the urodynamic parameters from the pressure-flow analysis at baseline and at 6 months, all of which were statistically significant (p < 0.0001).

For each different fiber the changes in the parameters are shown in table 3. No major differences in these parameters among the 3 different fibers were noted. For the Ultraline and Urolase fibers a statistical improvement was noted in all parameters. Although an absolute improvement was noted in all parameters, for the TULIP device there was no statistical improvement in post-void residual volume, detrusor pressure at maximum flow rate and minimal detrusor pressure. The few patients in the TULIP group (7) should be considered.

Depending on what obstruction parameter was used, the incidence of preoperative urodynamic obstruction ranged from 65 to 90%. Postoperatively 8 to 18% of the patients still can be considered as having obstruction (table 4). Figure 1 shows the preoperative and postoperative values for detrusor pressure at maximum flow rate in all patients using the nomogram of obstruction reported by Abrams and Griffiths.11 Figure 2 is a visual representation of the urodynamic parameters used in a pressure-flow plot before and after laser treatment.

DISCUSSION

In view of all the new available treatment options, guidelines to standardize the assessment of BPH therapies are being developed, including among other things uroflowmetry (voided volume, maximum flow rate and post-void residual volume), blood studies and urinalysis (including PSA), prostate size and weight, international prostate symptom score assessment, cystometry with simultaneous assessment of intravesical and intra-abdominal pressure for determination of detrusor pressure and pressure-flow studies.14,15 To achieve results similar to those of transurethral resection of the prostate new treatment modalities should have the ability to relieve outlet obstruction. To document changes in the grade of obstruction a considerable number of parameters have been suggested. Although symptom scores, uroflowmetry studies, post-void residual volume and prostate size are associated with outlet obstruction, there appears to be no clear correlation with the grade of outlet obstruction. Simultaneous measurements of intravesical pressure and flow rate during voiding enable one to distinguish objectively between obstruction or no obstruction. Consequently, advanced urodynamics (including pressure-flow analysis) are considered the best methods to document (changes in) the grade of bladder outlet obstruction.

Since Abrams and Griffiths in 1979 first reported urodynamic changes after surgical intervention for BPH,11 there have been few other studies about this subject.17–21 Studies concerning the evaluation of urodynamic changes in alternative BPH treatments are even more rare.22–25 Available data suggest that urodynamic changes, if any, are minimal. None of these studies has shown urodynamic changes similar to those after transurethral resection of the prostate.

To date, to our knowledge only 2 studies have been presented using pressure-flow parameters for evaluation of treatment outcome after laser therapy. Bosch and Groen showed a decrease in detrusor pressure at maximum flow rate and urethral resistance relation after laser therapy of the prostate using the TULIP device.20 Detrusor pressure at maximum flow rate improved from 76 cm. water (range 26 to 200) at baseline to 39 cm. water (range 18 to 58) at 3 months and urethral resistance relation decreased from 42 (range 22 to 78) to 22 (range 11 to 35). In our study detrusor pressure at maximum flow rate changed from 76 cm. water (range 38 to 194) at baseline to 39 cm. water (range 15 to 74), and the urethral resistance relation improved from 49 (range 20 to 130) to 19 (range 7 to 40) at 6 months. We agree with the conclusion that TULIP laser treatment of the prostate is urodynamically effective for BPH. A randomized laser versus transurethral resection of the prostate study by Gill and Kabelin showed an equal improvement in opening pressure and maximal detrusor pressure in both treatment arms.27 They concluded that symptom scores and objective urodynamic parameters demonstrated laser prostatectomy to be effective treatment of bladder outflow obstruction secondary to BPH. Our results confirmed this conclusion.

No consensus has been reached to date on which parame-
TABLE 2. Urodynamic changes and symptom score improvement before and 6 months after laser prostatectomy in 40 patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before</th>
<th>After</th>
<th>Individual Improvement</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom score (Uro)</td>
<td>21.7 ± 6.7</td>
<td>6.3 ± 4.6</td>
<td>15.4 ± 8.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Post-void residual urine (ml.)</td>
<td>899 ± 102.6</td>
<td>52 ± 38.4</td>
<td>710 ± 102.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Free flow maximum flow rate (ml/sec.)</td>
<td>80 ± 3.1</td>
<td>17.1 ± 6.9</td>
<td>9.0 ± 6.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow rate (cm. water)</td>
<td>38.3 ± 15.6</td>
<td>37.4 ± 29.8</td>
<td>5.9 ± 4.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Urethral resistance relation (cm. water)</td>
<td>45.5 ± 22.4</td>
<td>18.7 ± 8.6</td>
<td>22.8 ± 22.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Minimum detrusor pressure (cm. water)</td>
<td>41.3 ± 23.9</td>
<td>17.3 ± 10.0</td>
<td>24.5 ± 23.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Theoretical cross-sectional urethral area (mm.²)</td>
<td>2.3 ± 1.1</td>
<td>7.5 ± 4.1</td>
<td>5.5 ± 4.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Linear passive urethral resistance relation</td>
<td>3.5 ± 1.9</td>
<td>1.0 ± 1.0</td>
<td>2.6 ± 1.9</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

* Not significant.

TABLE 3. Mean improvement (plus or minus standard deviation) in different parameters for each different fiber at baseline and at 6-month followup

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TULIP (7 pts.)</th>
<th>Uroline (19 pts.)</th>
<th>Ultraline (14 pts.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom score (Uro)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free flow maximum flow rate (ml/sec.)</td>
<td>21.8 ± 8.0</td>
<td>7.6 ± 5.2</td>
<td>14.3 ± 6.4</td>
</tr>
<tr>
<td>Post-void residual urine (ml.)</td>
<td>68 ± 70</td>
<td>22 ± 40</td>
<td>60 ± 22</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow rate (cm. water)</td>
<td>81 ± 48</td>
<td>46 ± 11</td>
<td>72 ± 51</td>
</tr>
<tr>
<td>Urethral resistance relation (cm. water)</td>
<td>53 ± 35</td>
<td>21 ± 8</td>
<td>48 ± 22</td>
</tr>
<tr>
<td>Minimum detrusor pressure (cm. water)</td>
<td>46 ± 33</td>
<td>22 ± 8</td>
<td>40 ± 22</td>
</tr>
<tr>
<td>Theoretical cross-sectional urethral area (mm.²)</td>
<td>2.3 ± 1.3</td>
<td>6.9 ± 3.7</td>
<td>2.4 ± 1.0</td>
</tr>
<tr>
<td>Linear passive urethral resistance relation</td>
<td>3.7 ± 1.1</td>
<td>1.3 ± 0.8</td>
<td>3.5 ± 1.4</td>
</tr>
</tbody>
</table>

TABLE 4. Different criteria for grade of obstruction and percentage of patients matching these obstruction criteria before and 6 months after laser prostatectomy in complete group of 40 patients

<table>
<thead>
<tr>
<th>Obstruction</th>
<th>Before (%)</th>
<th>After (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear passive urethral resistance relation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 3</td>
<td>20 (50)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>3</td>
<td>12 (30)</td>
<td>3 (8)</td>
</tr>
<tr>
<td>Less than 3</td>
<td>8 (20)</td>
<td>37 (92)</td>
</tr>
<tr>
<td>Urethral resistance relation more than 29 cm. water</td>
<td>36 (90)</td>
<td>4 (10)</td>
</tr>
<tr>
<td>Minimum detrusor pressure more than 29 cm. water</td>
<td>26 (65)</td>
<td>7 (18)</td>
</tr>
<tr>
<td>Theoretical cross-sectional urethral area less than 3.0 mm.²</td>
<td>33 (83)</td>
<td>4 (10)</td>
</tr>
<tr>
<td>Detrusor pressure at maximum flow rate:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstructed</td>
<td>52 (80)</td>
<td>4 (10)</td>
</tr>
<tr>
<td>Equivocal</td>
<td>8 (20)</td>
<td>20 (50)</td>
</tr>
<tr>
<td>Unobstructed</td>
<td>0 (0)</td>
<td>18 (40)</td>
</tr>
</tbody>
</table>

Fig. 1. Changes in detrusor pressure ($P_{det}$) at maximum flow rate ($Q_{max}$) before and 6 months after laser prostatectomy using Abrams-Griffiths nomogram for obstruction in all 40 patients.
prostatectomy (Figs. 1 and 2) are similar to changes after transurethral resection of the prostate.11,20

A considerable number of studies concerning laser treatment have been published, and many different fibers and energy settings have been used. To date no major differences in outcome have been reported using these different fibers. The general results are the same and are comparable with results after transurethral resection of the prostate.2-7 In our study 3 different types of fibers were used. Although not randomized and with few patients in each group, no differences in the extent of obstruction relieved among these 3 fibers could be found (table 3). Laser energy seems to be capable of relieving outlet obstruction. The method of applying the energy appears to be secondary, and the treatment success depends largely on the preference and skills of the surgeon in using the various techniques. The different morbidity rates caused by the various fibers and techniques should also be considered. The long-term results may be different for each fiber or technique used and related to the ability to create cavities.

Transurethral resection of the prostate remains the gold standard in the treatment of BPH to which all other new treatment modalities should be compared. The objective of surgical treatment for prostatic obstruction must be to relieve obstruction safely and effectively no matter what procedure or technique is used. The reasons for considering transurethral resection of the prostate as the most effective therapy are the excellent objective and subjective results reached and sustained for a long period. To date none of the alternative treatments has accomplished similar or even better results. With regard to laser prostatectomy, improvements in symptoms and uroflowmetry are impressive, and to a great extent comparable to the results reached after transurethral resection of the prostate.2-6 However, long-term effects are not yet available and only speculations can be made about the final effect in the future.29,30 A possibility to predict a long lasting effect might be the presence of a cavity on urethrocystoscopy or transrectal ultrasound of the prostate as a result of laser therapy. Moreover, the changes in obstructive voiding to nonobstructive voiding measured in a pressure-flow analysis can contribute to a more accurate prediction.

We are aware that controversy still exists about whether to perform a complete urodynamic evaluation routinely in pa-

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**Fig. 3.** Correlation between improvement in symptom score (IPSS) and improvement in urethral resistance relation (URA, intersection of quadratic urethral resistance relation with pressure axis in pressure-flow plot in cm. water) for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.

**Fig. 4.** Correlation between improvement in symptom score (IPSS) and improvement in minimal detrusor pressure with ongoing flow in cm. water (Pvoidmin) for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.

**Fig. 5.** Correlation between improvement in symptom score (IPSS) and improvement in maximum flow rate (Qmax) in cm. water for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.

**Fig. 6.** Correlation between improvement in symptom score (IPSS) and improvement in detrusor pressure (Pdet) at maximum flow rate (Qmax) in cm. water for all 40 patients after laser treatment. ▲, patients who at baseline could not be considered to have obstruction.
patients with BPH, and about the clinical relevance of precisely grading the obstruction. We believe that to date urodynamic investigations with pressure-flow analysis should first be considered as an essential research tool to evaluate best the outcome of alternative treatments for BPH. Moreover, we must determine the role of routine urodynamic investigation in the assessment of BPH in daily urological practice. More studies with different treatment modalities are needed to conclude if pressure-flow analysis can be used not only to demonstrate the type and grade of obstruction but also to select patients for different (alternative) treatment options. Interestingly, Tubaro et al showed that the treatment outcome of transurethral microwave thermotherapy could be predicted from pressure-flow analysis, making patient selection possible. Finally, to solve the question of which fiber or technique used is superior in providing long lasting relief of obstruction, randomized studies with obligatory urodynamic and pressure-flow analyses are mandatory.

CONCLUSIONS

Urodynamic evaluation with pressure-flow analysis of treatment outcome after laser prostatectomy shows that laser is capable of relieving outflow obstruction comparable to results obtained with transurethral resection of the prostate. No apparent difference in ability to relieve obstruction was shown for the different fibers and techniques. To evaluate the ability to provide long lasting relief of obstruction for each different fiber, randomized studies with urodynamic evaluation and pressure-flow analyses are mandatory.

REFERENCES


